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ArcGIS Analysis of Riparian Zone Restoration Potential in the Middle Creek – Penns Creek HUC-12 Watershed

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Abstract

The Middle Creek-Penns Creek HUC-12 watershed in Snyder County, PA (Figure 1) contains 49 miles of impaired streams out of 73 total miles of waterways. These impaired streams fail to meet their regulatory uses for "aquatic life" and/or "recreational" designations. In order to restore the waterways, best management practices (BMPs) can be installed to reduce nutrients, such as nitrogen and phosphorus, and sediment loads. A spatial analysis of the watershed was created in ArcGIS to identify sub-watersheds within this HUC-12 region that have the largest potential for restoration and implementation of BMPs in riparian zones, taking into account land use, hydrology, impaired streams, and landowner property parcels. The Model my Watershed (MMW) online analysis program was utilized to model how specific BMPs will quantitatively reduce nutrient and sediment loads in this watershed. These analyses will contribute to the development of a Watershed Implementation Plan (WIP) for the Middle Creek-Penns Creek watershed.

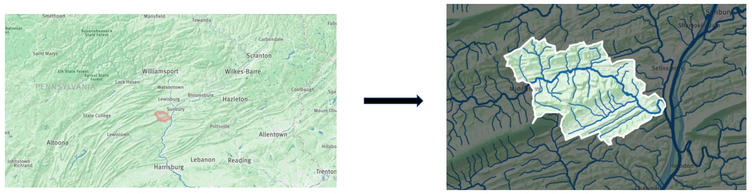

Figure 1. Middle Creek - Penns Creek HUC 12 Watershed highlighted in red, in relation to the greater Pennsylvania area (Model my Watershed, 2019).

Background

Of the 85,146 miles of streams in PA, 29,883 miles are impaired for one or more designated uses. This study lays the foundation for the creation of a WIP in one small watershed, Middle Creek–Penns Creek. The WIP must include a ranked priority list of land parcels along impaired streams that are suitable for BMP installation. In this study, the watershed is characterized through a GIS analysis of the causes of stream impairment, topography, land cover, soil type, and landowner property parcels. From this data, the properties or streams that are impaired and show the highest opportunity for BMP implementation within a 10-meter buffer strip are identified to create a prioritized list. Subwatersheds within this HUC-12 watershed are then identified, and the subwatershed with the highest cumulative priority ranking will be targeted for future restoration.

Methods

Two analytical tools were used: 1) Esri ArcGIS's main suite component, ArcMap, and 2) Model my Watershed. Figures 2 and 3 show the ArcMap data input and analysis process. Each layer was clipped to the HUC-12 watershed boundary. Figure 3 depicts a cartographic model of the ArcGIS methods. Through Model my Watershed, each conservation practice was applied at its maximum acreage and individually applied to the watershed as a single scenario. Figure 4 highlights the resultant pollutant loads for sediment, nitrogen, and phosphorous.

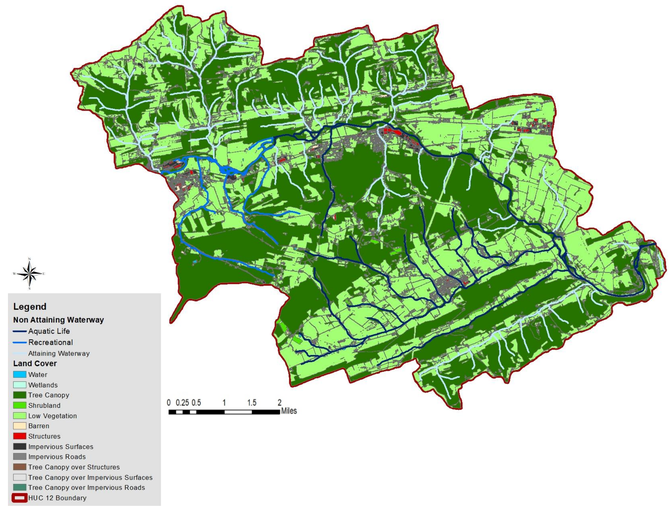

Figure 2. Map of the watershed with land cover and the designated attaining and non-attaining waterways, characterized by what they fail to attain for.

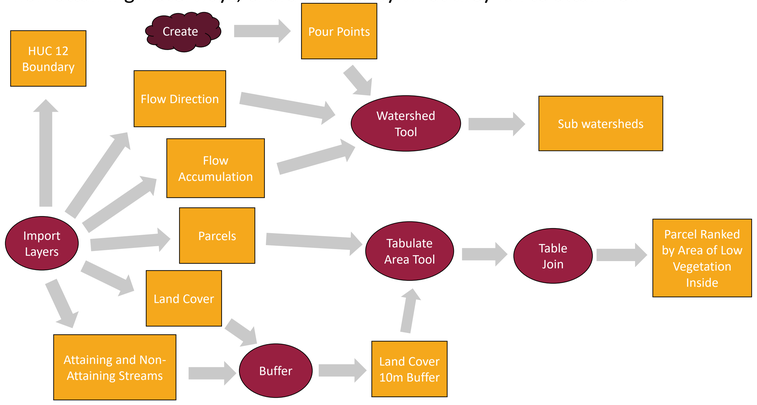

Figure 3. A cartographic model depiction of the methods that were conducted through ArcGIS to gain data and a spatial analysis of the watershed area.

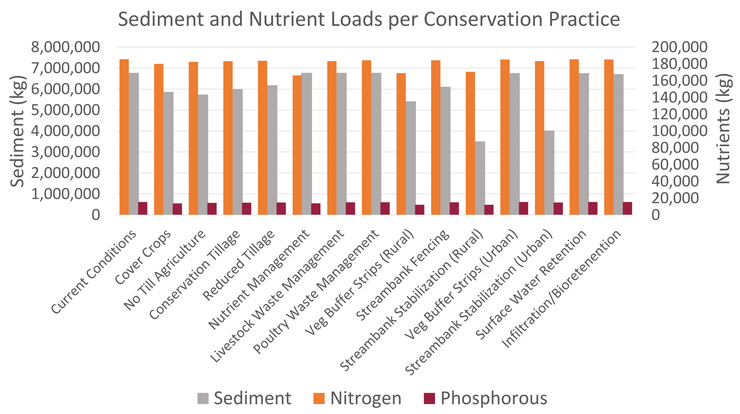

Figure 4. Pollutant loads per 100% BMP application produced through MMW. Sediment (grey) uses the left axis, and the nutrients use the right axis.

Results & Discussion

According to the analysis from ArcGIS and Model my Watershed, this data can be cross referenced and combined to choose which BMPs to utilize where. Streambank stabilization produced the most reductions in sediment and phosphorous, therefore this conservation practice should be utilized. The area at the headwaters of the Susquehecka Creek has the most low vegetation lining the streams, shown in Figure 5. This area would largely benefit from streambank stabilization or the use of vegetated buffers. By using the most effective BMPs in the areas that have the most opportunity for implementation, the impairments will decrease in the most effective way.

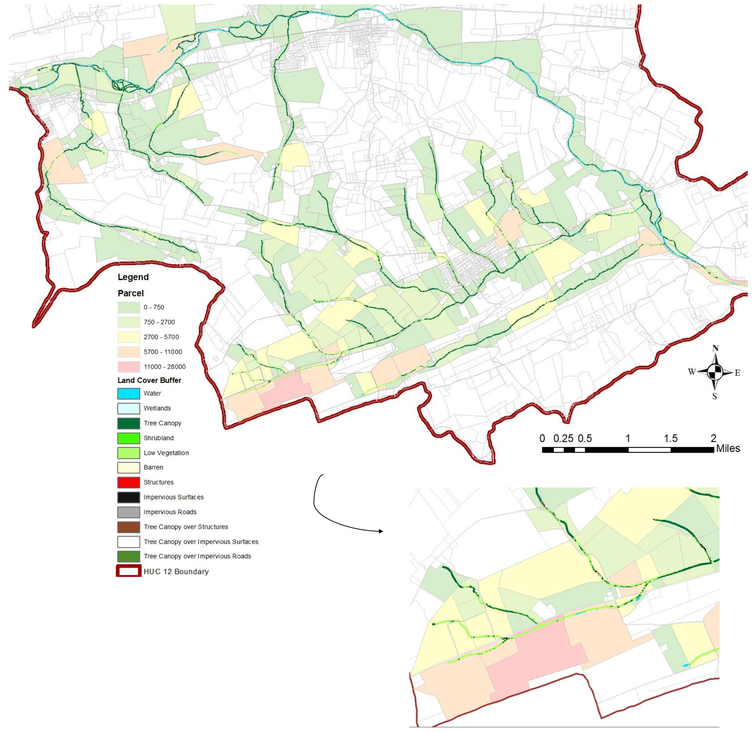

Figure 5. Map of the non-attaining waterways with a 10-meter buffer consisting of the land cover over that area. The background displays the parcel outlines within the watershed. The delineated parcels by color represent the amount of area (ft^2) of low vegetation. A detailed section of the beginning portion of the Susquehecka Creek is shown.

Conclusions

This research is just the beginning in investigating how to best restore the non-attaining streams within the Middle Creek – Penns Creek HUC 12 Watershed. The development of this analysis creates a base from which more research can aid the 319 Nonpoint Source Management Grant future. Through the enhanced data collection by Model my Watershed and ArcGIS, nonpoint source management efforts can reduce pollution within the watershed